1. Observatory, Meteorology, and Data Management Operations

1.1. MAUNA LOA OBSERVATORY

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1.1.1. OPERATIONS

The most noticeable change to the Mauna Loa Observatory (MLO), Hawaii, was moving the Jet Propulsion Laboratory (JPL) ozone lidar from the trailers into the Network for the Detection of Stratospheric Change (NDSC) building in March 2001. This move was long awaited and went smoothly. The trailers were moved to the upper parking lot for equipment removal and will be returned to JPL in the future. After the trailers were moved, construction was started in August 2001 on a new lidar building to house a Doppler lidar built by Michigan Aerospace to measure wind from the ground through the troposphere. The project is being funded by NOAA and managed by the University of New Hampshire. The old radiation platform above the Keeling building was modified for new mercury detection equipment installed by the Environmental Protection Agency (EPA) in August 2000. The top section of the platform was removed and the lower part reinforced.

U.S. Army contractors installed a new pole for the Army's radio repeater antenna. The pole is downslope from MLO and should solve a previous electrical noise problem with the National Institute of Water and Atmospheric Research/ultraviolet (NIWA/UV) spectrometer. The contractors also began modifying the visitor building to house the radio equipment. A scientific drilling group for the Hawaii Volcano Observatory (HVO), U.S. Geological Survey (USGS), drilled a 140-m (400-ft) well for the placement of a seismometer and strain gauge for monitoring Mauna Loa volcano. The instruments and telemetry are solar powered and located on the edge of the helicopter pad.

Observatory use by visiting groups for short-term calibrations of their instruments (of a few weeks duration) continued to increase. There were many repeat visits as well as several new groups. For the most part, the instruments are for various solar radiation measurements of varying complexity. One Japanese group left an instrument running unattended for several weeks, returning to pack and ship the instrument back to Japan. Computer network connections were added to the visitor building to accommodate them.

John Chin, who retired after more than 30 years of service at MLO, was replaced by an electrical engineer with experience at Pearl Harbor with the Department of Defense and with telescopes on Mauna Kea.

Outreach

Requests to visit the observatory continued, many through the Internet. Several classes from the University of Hawaii at Hilo toured MLO, and several lectures were given by the station chief on campus. A National Aeronautics and Space Administration/Earth Observing System (NASA/EOS)/Aqua Satellite educational webcast was transmitted through MLO's Internet connection in May 2000. MLO personnel were filmed and interviewed, and participated in the online discussions with the elementary schools that were logged on.

The MLO station chief lectured on climate change and pollution to a group of 60 senior citizens in Kona and to about 20 at an Aloha Exchange Club meeting. He also judged the Hawaii County Science Fair and presented awards for environmentally related projects. Two high school summer students were mentored each summer on short data analysis projects for part of the University of Hawaii at Hilo's Upward Bound project. Two university students also worked summers on the lidar program, one from the University of Pennsylvania and the other from the University of Hawaii at Hilo.

A MLO scientist received the Department of Commerce bronze medal for his work with the Hawaii schools Volcano Gas observatory Network (VOGNET). The VOGNET program began its sixth year in 2001. A prototype PC-operated continuous condensation nuclei (CN) counter was developed and tested in the summer of 2000 at MLO. This CN counter can be built by students for $450 with readily available parts. Hawaii Preparatory Academy (HPA) received a grant from the local electric company to fund a network of these instruments at schools around the Big Island. In spring 2001 students and teachers at six schools began assembling their CN counters, which were then tested and calibrated at MLO/Hilo in August-September 2001. At the end of 2001, the instruments, connected to the central HPA data archival computer by modem, were collecting continuous data at the schools. A web page developed and run by HPA students will provide the public with near-real-time information on the levels of volcanic pollution around the island.

Computers/Network

The networks at the Hilo office and at portions of the mountain site have been changed from the older coax type to the 10 base-T type. The Hilo office was upgraded further by installating fast Ethernet devices running at 100 megabits on its Local Area Network (LAN). The router in the Hilo office, three computers, and two network printers were obtained from excessed census equipment. More network hubs were added at various locations at the observatory to accommodate increased visiting projects requiring Internet access. Most of the computers and network devices are now on some type of uninterruptible power supply (UPS). At the end of 2001 MLO had 51 computers at its site. Three additional racks were installed to provide a more efficient use of space.

MLO's domain name was changed at the Hilo site from "mlo.hawaii.gov" to "mlo.noaa.gov" and is officially registered in the NOAA database. This allows the staff access to NOAA sites to obtain data and programs without a fee. It affects only the MLO Hilo addresses. The U.S. Fish and Wildlife Service still retains the "mlo.hawaii.gov" address, and the mountain site remains at "mtn.noaa.gov". MLO's new web address is "www.mlo.noaa.gov". In June the High Altitude Observatory (HAO) installed its own 56-K line at the observatory. HAO is now independent from the

MLO network at the mountain site. The U.S. Fish and Wildlife Service continues to be connected to the MLO Hilo network via a wire repeater.

Security has been a major focus. Automatic virus scanning and definition updates are done every day on the networks at both the Hilo and mountain sites. In 2001 MLO had 14 different types of virus infections compared with none in the years before. The File Transfer Protocol (FTP) server was abused, causing mass slowdowns in Internet access. A dedicated FTP server was set up with strict access configurations. A biometric fingerprint scanner was set up on the main mountain observatory computer to prevent non-MLO staff accessing it. A computer was installed to accommodate visitors. The office administration computer now has a personal firewall, and a password is needed to boot the computer. The computer room at the observatory is now always locked and is off limits to the public.

MLO had its first webcast on May 11, 2000. MLO participated in the "You Be the Scientist" program sponsored by NASA Goddard. The broadcast originated from the Hilo Federal building and used MLO's network as its access point. On October 17, 2000, MLO had its first video conference interview. A MLO staff member was interviewed by film students from Germany about MLO's web cam setup and general information about the observatory. The video conference was recorded and became part of a documentary about web cams around the globe.

MLO has seven web cams. Two new cameras were installed to monitor the CMDL solar trackers and the EPA mercury equipment. MLO's website had to be modified to become NOAA security compliant. Other improvements to MLO's website included more links to live data, updates of the history section, and changes in staff listings and contact information.

1.1.2. PROGRAMS

Table 1.1 summarizes the programs in operation or terminated at MLO during 2000-2001. Relevant details on some of the respective programs follow:

Gases

Flask sampling. The weekly CO_2, CH_4, O_2, and other flask sampling programs were carried out at MLO and at Cape Kumukahi according to schedule. The O_2 and halocarbon sampling was disrupted for 2 weeks in May and June 2001 while contractors refurbished the Cape Kumukahi lighthouse tower.

Carbon dioxide. The CMDL Siemens Ultramat-3 infrared (IR) CO_2 analyzer operated without problems in 2000-2001. CO_2 emissions from Mauna Loa volcano continued their steady decline since the 1984 eruption and have almost reached record low levels measured at MLO in the early 1970s.

Carbon monoxide. A Trace Analytical reduction gas analyzer (RGA3) is used for the continuous measurement of CO at MLO. Mixing ratios of up to 200 parts per billion (ppb) were measured in springtime Asian transport events, and mixing ratios less than 30 ppb were observed in air transported from the tropics in late summer. In February 2001 a dual-tank manifold was installed on the nitrogen tank to facilitate tank replacement. Beginning in 2001, analyzer lamps were replaced more frequently (every few months) to maintain the highest possible precision in the data.

Methane. The Hewlett-Packard (HP6890) methane gas chromatograph (GC) system operated without problems throughout 2000-2001. In February 2001 a dual-tank manifold was installed on the oxygen/nitrogen and nitrogen tanks to allow tank changes without stopping the GC.

Sulfur Dioxide. A TECO 43-S pulsed-fluorescence analyzer is used to measure SO_2 with a detection limit of 50 parts per trillion (ppt) for a 1-h measurement. Each hour samples are taken sequentially from inlets at 4, 10, 23, and 40 m on the tower, followed by a filtered zero measurement. A single-point calibration is made once per day by injection of calibration gas into the airstream at the 40-m inlet. In February 2000 the upper portion of the sampling line was replaced. Pollution from the continuing Kilauea volcano eruption produced afternoon mixing ratios of up to 140 ppb. Mixing ratios of a few hundred parts per trillion were measured when the quiescent Manua Loa volcanic plume was present at night (10% of the time). The molecular ratio of SO_2 to CO_2 from Mauna Loa volcano remained low, at about 5×10^{-5} throughout 2000-2001.

Ozone monitoring. The 2000-2001 MLO ozone monitoring program consisted of three measurement foci: continuous MLO surface ozone monitoring with a Dasibi model 1003-AH UV absorption ozone monitor; daily total and Umkehr ozone profile measurements with a computer-based automated Dobson instrument (Dobson no. 76); and ozone profile measurements based on weekly ascents of balloonborne electrochemical concentration cell (ECC) ozonesondes released from the National Weather Service (NWS) station at the Hilo airport.

The Dasibi program operated normally throughout 2000-2001. The Dasibi was calibrated, yearly maintenance was carried out, and absorption tubes were cleaned. In August 2000 the unit was returned to Boulder for repairs and was lost in transit. A replacement was installed in October and operations resumed.

Dobson instrument 76 operated daily during weekdays throughout the period with daily AM/PM Umkehr runs. Summer intercomparisons with standard Dobson instrument 83 were made in both 2000 and 2001. The instrument was maintained as needed with pedestal unit repairs, wedge motor replacement, dome (hatch and shutter) work, lower shutter assembly repairs, photon coupler interrupter replacement, and miscellaneous motor, belt, and tension spring adjustments. In August 2001 the computer was upgraded with new hardware and software.

Ozonesondes were launched weekly whenever supplies were available from Boulder. There were 45 flights in 2000 and 60 flights in 2001. An intensive campaign of 21 ozonesonde flights was carried out as part of the Transport and Chemical Evolution over the Pacific (TRACE-P) experiment in March and April 2001, which looked at tropospheric transport of polluted air from Asia.

Halocarbons and other atmospheric trace species. In April 2000 the Radiatively Important Trace Species (RITS) unit had the Shimadzu GC and Channel A of the HP-GC turned off as intercomparisons were completed. Channel B

TABLE 1.1. Summary of Measurement Programs at MLO in 2000-2001

Program/Measurement	Instrument	Sampling Frequency
Gases		
CO_2	Siemens Ultramat-3 IR analyzer*	Continuous
	2.5-L glass flasks, through analyzer	1 pair wk^{-1}
CO	Trace Analytical RGA3 no. R5*	Continuous
CO_2, CH_4, CO, and ^{13}C, ^{18}O of CO_2	2.5-L glass flasks, MAKS pump unit	1 pair wk^{-1}
	AIRKIT pump unit, 2.5-L glass flasks†	1 pair wk^{-1}
CH_4	3-L evacuated glass flasks†	1 pair wk^{-1}
	HP6890GC*	Continuous
SO_2	TECO model 43-S pulsed-fluorescence analyzer; 4, 10, 23, 40 m*	Continuous
Surface O_3	Dasibi 1003-AH UV absorption ozone monitor*	Continuous
Total O_3	Dobson spectrophotometer no. 76*	3 day^{-1}, weekdays
O_3 profiles	Dobson spectrophotometer no. 76* (automated Umkehr method)	2 day^{-1}
	Balloonborne ECC sonde	1 wk^{-1}
N_2O, CFC-11, CFC-12, CFC-113, CH_3CCl_3, CCl_4, SF_6, HCFC-22, HCFC-21, HCFC-124, HCFC-141b, HCFC-142b, CH_3Br, CH_3Cl, CH_3I, CH_2Cl_2, $CHCl_3$, C_2Cl_4, H-1301, CH_2Br_2, $CHBr_3$, H-1211, HFC-134a, HCFC-152a, C_6H_6, COS	850-mL, 2.5-L, or 3-L stainless-steel flasks	1 pair wk^{-1}
CFC-11, CFC-12, CFC-113, N_2O, CCl_4, CH_3CCl_3	HP5890 automated GC* (ended 12/00)	1 sample h^{-1}
N_2O	Shimadzu automated GC* (ended 4/00)	1 sample h^{-1}
CFC-11, CFC-12, CFC-113, N_2O, CH_3CCl_3, CCl_4, CH_3Br, CH_3Cl, H-1211, SF_6, HCFC-22, COS, $CHCl_3$, HCFC-142b	Automated CATS GC	1 sample h^{-1}
Aerosols		
Condensation nuclei	Pollak CNC (removed 5/01)	1 day^{-1}
	TSI 3760 CNC* (removed 5/01)	Continuous
	TSI 3010 CNC	Continuous
Aerosol light scattering	Three-wavelength nephelometer: 450, 550, 700 nm (removed 5/01)	Continuous
Condensation nuclei/optical properties	Automated atmospheric sampling system. Main components: TSI-CNC, three-wavelength nephelometer (450, 550, and 700 nm); light absorption photometer (Radiance Research PSAP) (began 5/00)	Continuous
Aerosol light absorption (black carbon)	Aethalometer*	Continuous
Stratospheric and upper tropospheric aerosols	Nd:YAG lidar: 532-, 1064-nm wavelengths	1 profile wk^{-1}
Solar Radiation		
Global irradiance	Eppley pyranometers with Q, OG1, and RG8 filters*	Continuous
Direct irradiance	Two Eppley pyrheliometers with Q filter*	Continuous
	Eppley pyrheliometer with Q, OG1, RG2, and RG8 filters*	3 day^{-1}
	Eppley/Kendall active-cavity radiometer*	1 mo^{-1}
Diffuse irradiance	Eppley pyrgeometer with shading disk and Q filter*	Continuous
UV solar radiation	Yankee Environmental UVB pyranometer (280-320 nm)*	Continuous
	UV/VIS spectroradiometer	>5º solar zenith angle
Turbidity	J-202 and J-314 sunphotometers with 380-, 500-, 778-, 862-nm narrowband filters	3 day^{-1}, weekdays
	PMOD three-wavelength sunphotometer: 380, 500, 778 nm; narrowband* (ended 4/01)	Continuous
	Precision filter radiometer (368, 412, 500, 862 nm)*	Continuous
Column water vapor	Two-wavelength tracking sunphotometer: 860, 940 nm (two instruments)*	Continuous
Terrestrial IR Radiation	Precision infrared radiometer, pyrgeometer*	Continuous

TABLE 1.1. Summary of Measurement Programs at MLO in 2000-2001—continued

Program/Measurement	Instrument	Sampling Frequency
Meteorology		
Air temperature	Aspirated thermistor, 2-, 9-, 37-m heights*	Continuous
	Max.-min. thermometers, 2.5-m height	1 day^{-1}, weekdays
Air temperature (30-70 km)	Lidar	1 profile wk^{-1}
Temperature gradient	Aspirated thermistors, 2-, 9-, 37-m heights*	Continuous
Dewpoint temperature	Dewpoint hygrometer, 2-m height*	Continuous
Relative humidity	TSL, 2-m height*	Continuous
Pressure	Capacitance transducer*	Continuous
Wind (speed and direction)	8.5-, 10-, and 38-m heights*	Continuous
Precipitation	Rain gauge, 20-cm diameter	5 wk^{-1}
	Rain gauge, 20-cm diameter‡	1 wk^{-1}
	Rain gauge, tipping bucket*	Continuous
Total precipitable water	Foskett IR hygrometer*	Continuous
Precipitation Chemistry		
pH	pH meter	1 wk^{-1}
Conductivity	Conductivity bridge	1 wk^{-1}
Cooperative Programs		
CO_2 (SIO)	Applied Physics IR analyzer*	Continuous
CO_2, ^{13}C, N_2O (SIO)	5-L evacuated glass flasks§	1 pair wk^{-1}
CO_2, CO, CH_4, $^{13}C/^{12}C$ (CSIRO)	Pressurized glass flask sample	3 pair mo^{-1}
O_2 analyses (SIO)	5-L glass flasks through tower line and pump unit§	3 $(2\ mo)^{-1}$
Total suspended particulates (DOE)	High-volume sampler	Continuous (1 filter wk^{-1})
Ultraviolet radiation (CSU and USDA)	Multi-wavelength radiometer (direct, diffuse, shadow band)	Continuous
Radionuclide deposition (DOE)	Ion-exchange column	Quarterly sample
Aerosol chemistry (Univ. of Calif., Davis)	Programmed filter sampler	Integrated 3-day sample, 1 continuous and 1 downslope sample $(4\ days)^{-1}$
Hg°, Hg^{+2}, Hg^p (EPA/NERL)	Tekran 2537A, 1130 and 1135p (began 7/01)	Continuous
Particulate 2.5-10 µm (EPA/NERL)	Dichotomous Partisol-Plus Model 2025 (began 8/01)	1 downslope sample wk^{-1}
Sulfate, nitrate, aerosols (Univ. of Hawaii)	Filter system	Daily, 2000-0600 LST
Radon (ANSTO)	Aerosol scavenging of Rn daughters; two-filter system*	Continuous; integrated 30-min samples
AERONET sunphotometers (NASA Goddard)	Automated solar-powered sunphotometers	Continuous
Global Positioning System (GPS) Test Bed (FAA and Stanford University)	GPS-derived column water vapor profiles	Continuous
Earthquakes (HVO-USGS Menlo Park)	Seismometer	Continuous
Earthquakes (Northwestern University)	Seismometer (ended 6/01)	Continuous
CO isotopes (SUNY)	1000 psi cylinder	1 wk^{-1}
Cosmic dust (CALTECH)	Magnetic collector	1 wk^{-1} (ended 1/01); 1 $(2\ wk)^{-1}$ (began 1/01)
Volcanic activity (HVO)	Seismic and expansion instrument in 370-ft-deep well	Continuous
Network for the Detection of Stratospheric Change (NDSC)		
Ultraviolet radiation (NOAA and NIWA)	UV spectroradiometer (285-450 nm), 0.8-nm resolution*	Continuous
Stratospheric O_3 profiles, 20-66 km (Univ. of Mass., Amherst)	Millitech Corp., 110.8-GHz microwave ozone spectroscopy	3 profiles h^{-1}
Stratospheric water vapor profiles, 40-80 km, 10-15 km resolution (NRL)	Millimeterwave spectrometer	Continuous
Stratospheric O_3 profiles (15-55 km), temperature (20-75 km), aerosol profiles (15-40 km) (JPL)	UV lidar*	3-4 profiles wk^{-1}
NO_2 (NIWA and NOAA)	Slant column NO_2 spectrometer	Continuous, daytime
BrO (NIWA and NOAA)	Column BrO spectrometer	Continuous, daytime
Column O_3, UVB (AES, Canada)	Two Brewer spectrophotometers	Daily
Solar spectra (Univ. of Denver)	FTIR spectrometer, automated*	5 days wk^{-1}

All instruments are at MLO unless indicated.
*Data from this instrument recorded and processed by microcomputers.
†Kumukahi only.
‡Kulani Mauka.
§MLO and Kumukahi.

remained on line. The Chromatograph for Atmospheric Trace Species (CATS) GC had a new computer installed in January 2001. In April 2001 all halon fire extinguishers were removed from all buildings at MLO at the request of Boulder. This alleviated a noisy background trace that had existed for a while. In August 2001 the RITS and CATS units were shut down because the calibration tanks and valve replacement parts did not arrive. Normal operation resumed the next month when tanks and parts were received. The last remaining channel (B) on RITS was shut down in December 2000 as the last few intercomparisons were completed.

Aerosols

The Atmospheric Sampling System, installed in April 2000, is a new automated system for measuring aerosol light scattering as a function of wavelength, aerosol light absorption, and condensation nuclei. Two particle impactors are used to measure these properties for aerosol sizes less than 1 and 10 µm. The main components are a Thermo Systems Incorporated (TSI) three-wavelength nephelometer (model 3563), a Radiance Research particle soot absorption photometer (PSAP), and a TSI condensation nucleus counter (CNC; model 3760). The system measures the following parameters: total and backward scattering coefficient time series at 450-, 550-, and 700-nm wavelengths in two size ranges; absorption coefficient time series at 565 nm in two size ranges; and CN concentration time series. From the measurements the following parameters can be calculated: single scattering albedo at about 550 nm in two size ranges; Ångström coefficient; and hemispheric backward scattering fraction in two size ranges.

Condensation nuclei. The old TSI unit was shipped to Boulder in May 2001 after a year of comparison with the new TSI unit. The Pollak CNC is no longer in use and was moved to the Hilo office to calibrate the VOGNET continuous CNCs.

Aerosol light scattering. The three-wavelength nephelometer measuring at 450, 550, and 700 nm was shipped to Boulder in May 2001 after a year of comparison with the replacement nephelometer.

Aerosol light absorption. The aethalometer was found to be non-Y2K compliant. When a lengthy power failure occurs, the instrument's year resets to 1994. MLO staff must manually reset the date to the current year. In August 2000 the roller mechanism had to be repaired, which caused the unit to be down for 5 days. In July 2001 the instrument was sent to Magee Scientific to be upgraded. In October a new seven-wavelength spectrum aethalometer was installed at the observatory.

Stratospheric and upper tropospheric aerosols. Weekly observations continued with the Nd:YAG lidar throughout 2000 and 2001. The background period continued, and no stratospheric aerosol was conclusively measured from a volcanic eruption. Raman water vapor measurements were initiated in 2000 and improved with the purchase of new photomultiplier tubes optimized for the red part of the spectrum. The telescope optical support structure was extended to accommodate one of the 74-cm-diameter (long-focal-length) mirrors that had never been used. At that time the ruby telescope was remounted for testing. A proposal to NASA was funded to validate water vapor measurements from the Atmospheric Infrared Sounder (AIRS) instrument on the Aqua satellite. A computer power supply for the expansion chassis failed and was replaced in August 2001. Other maintenance consisted of flashlamp and cooling water changes for the laser.

Solar Radiation

The Physikalisch-Meteorologisches Observatorium Davos (PMOD) three-wavelength (380, 500, and 778 nm) sun-photometer was removed from service in April 2001 because of degraded filters. The normal incidence pyrheliometer (the data go back to 1958) is calibrated periodically against an active-cavity radiometer. Seven of these comparisons were done in 2000 and three in 2001. The active-cavity radiometer was sent to Boulder for intercomparisons in May 2001. Mauna Loa Observatory is also used to calibrate handheld sunphotometers by the Langley technique; two instruments were calibrated in 2000 and 14 were calibrated in 2001. The observatory is used to calibrate CMDL's Yankee UVB instruments; three were calibrated in 2000 and none were calibrated in 2001. SP01-A and SP02 instruments (four-channel tracking sunphotometers) were installed temporarily in the tracking dome for calibrations and comparisons with the precision filter radiometer. Two SP01-A instruments were installed in 2000, and two SP02 instruments were installed in 2001. A data line and a pressure sensor were connected to the HP data acquisition system, and a temperature controller was installed in the dome to support the SP02 installations.

Meteorology

A computer-based "New Met System" measures station pressure, temperatures at the 2-, 9-, and 37-m levels, dewpoint temperature at the 2-m level, and wind speeds and directions at the 8.5-, 10-, and 38-m levels of the MLO Observation Tower. Precipitation is measured with a tipping bucket rain gauge. This new system continues to operate unaltered and with high reliability.

Precipitation Chemistry

The MLO modified program of precipitation chemistry collection and analyses continued throughout 2000-2001 within the basic MLO operational routine. This program consists of collections of a weekly integrated precipitation sample from the Hilo NWS station and the collection of precipitation event samples at MLO. These samples are analyzed in the Hilo laboratory for pH and conductivity.

Cooperative Programs

MLO cooperative programs are listed in Table 1.1. New programs and changes not discussed in the NDSC section (next) are presented here.

In July 2001 two scientists from the U.S. EPA National Exposure Research Laboratory (NERL) arrived at MLO to install a mercury analyzer and dichotomous partisol sampler and train MLO staff on its operation and maintenance. On July 31, 2001, the mercury analyzer was placed on line. The system continuously measures elemental mercury (Hg°), reactive gaseous mercury (Hg^{+2}), and particulate mercury (Hg^p). On August 23, 2001, the particle sampler was activated. The State of Hawaii Health Department will weigh the filters from the partisol sampler. Filters are collected only during downslope conditions, and one filter sample is collected each week.

The Australian Nuclear Science and Technology Organization (ANSTO) has measured radon continuously at MLO since 1989. A new data logger and computer were installed in March 2000, and a new flow meter was installed in May 2001.

For the University of California, Davis, particulate special-event projects, the Asian Pacific Regional Aerosol Characterization Experiment (ACE-Asia)-MLO Collaboration, multistage drum units and hi-vol filters were installed/exposed in March 2000, March 2001, and August 2001 for approximately 6 weeks each and then shipped back to the University of California, Davis. The State University of New York (SUNY) CO isotope sample compressor failed in June 2001. The California Institute of Technology (CALTECH) cosmic dust collector continued to operate, although the weekly sampling was changed to biweekly in January 2001.

Network for the Detection of Stratospheric Change (NDSC)

All NDSC instruments from previous years continued observations. The NOAA lidar, ozonesonde, and Dobson operations, which are also part of the MLO NDSC facility, are described in other sections of this report.

Ultraviolet/Visible (UV/VIS) absorption spectroradiometer. The UV instrument began operation in the MLO NDSC building in November 1997. The UV spectroradiometer uses a double monochromator grating spectrometer to measure the UV spectrum between 285 and 450 nm with a resolution of 0.8 nm. Measurements are taken at 5° solar zenith angle intervals throughout the day. The instrument is calibrated weekly with a mercury lamp and a 45-W quartz lamp. An absolute-standard 1000-W FEL lamp calibration is performed twice each year. In August 2001 NIWA installed a new calibration lamp unit and a precision power supply unit. The power supply unit is programmable and maintains and controls the output current automatically during weekly calibrations.

Microwave ozone and water vapor spectroscopy systems. The University of Massachusetts microwave instrument measures the vertical profile of ozone from 20 to 66 km with a vertical resolution of 10 km or less up to 40 km, degrading to 17 km at 60 km. The ozone altitude distribution is retrieved from the details of the pressure-broadened line shape. The Naval Research Laboratory (NRL) operates a similar water vapor system that measures vertical profiles typically from 40 to 80 km. Both systems received the usual maintenance and continued operations in 2000 and 2001.

UV lidar. In March 2001 the JPL ozone lidar was moved out of the trailers and into the NDSC building. The move took about 6 weeks. A new Nd:YAG laser replaced one of the excimer lasers for better reliability for all-night operation during campaigns. JPL also used the opportunity offered by the move to extend the range of its measurements to lower altitudes by redesigning some of the optics and adding channels. The additional space has made the lidar easier to operate and maintain.

NO_2, BrO spectrometers. Since July 9, 1996, stratospheric NO_2 has been measured at MLO by the twilight-zenith technique with a NIWA UV/VIS spectrometer. Two additional spectrometers were added in December 1999 for column measurements of NO_2 and BrO. The BrO spectrometer is used to measure stratospheric bromine monoxide, an important species in current attempts to model future nonpolar ozone trends. The instruments can be operated over the Internet by NIWA in Lauder, New Zealand.

Brewer spectrophotometer. The measurements of O_3 and UVB radiation with a single monochromator Brewer instrument are supplemented by all-sky images recorded every 10 minutes to assist in the analysis of the UVB data. Overviews of the automatic operation of the instrument and data retrievals are carried out remotely from Atmospheric Environment Service (AES), now called Meteorological Service, in Toronto over the Internet. The data are archived at the World Ozone and Ultraviolet Data Centre (WOUDC) in Toronto. Up-to-date preliminary data are available over the Internet from AES. Publication of new results is planned after thorough analysis of a longer data record. This program continued throughout 2000-2001. Annual maintenance and calibration checks and other instrumentation calibrations were carried out in March 2000.

Solar Fourier transform infrared (FTIR) spectrometer. The University of Denver FTIR spectrometer routinely monitors HCl, HNO_3, O_3, N_2O, HCFC-22, HF, CH_4, NO, HCN, CO, C_2H_2, and C_2H_6. Because of the automatic nature of the instrument, the program is able to look at diurnal variations in the species. Data are not collected on Sundays or Monday mornings unless special operators are on site to add liquid nitrogen into the instrument.